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Cardiovascular Risk in Military Eligible Women

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13. ABSTRACT (Maximum 200 The overall hypothesis is that the decline in physical activity habits and resultant increase in body fat reduces exercise capacity and muscle mass in military women. These lifestyle changes worsen metabolic and cardiovascular risk factors. Therefore, continued involvement in resistance and endurance exercise programs which increases or preserves fat-free mass, as well as enhances physical activity will prevent functional declines in military-eligible women. Although exercise is frequently recommended to enhance overall fitness, it is unclear as to whether endurance or resistance exercise is more effective in attenuating functional and cardiovascular declines in women. We will systematically compare the effects of <u>endurance</u> and <u>resistance</u> exercise on physical activity, cardiovascular fitness, and fat metabolism in military eligible women.			
To accomplish this objective military eligible women (18 to 35 yrs) will be randomized to a 6-month endurance training, resistance training or a control group. We will determine the effects of endurance training and resistance training on changes in: 1) free-living physical activity using doubly labeled water and indirect calorimetry; 2) body composition and body fat distribution using dual energy x-ray absorptiometry and computerized tomography, 3) in-vivo fat oxidation from ¹³ C palmitate; and 5) insulin sensitivity from euglycemic clamps. Our results will provide new information on the energetic and physiological effects of endurance and resistance training on energy metabolism, cardiovascular fitness, and fuel utilization in women.			
We anticipate that the results from this study will provide the scientific basis for the recommended use of either endurance or resistance exercise as therapeutic modalities to increase physical activity, preserve fat-free mass, and decrease cardiovascular risk in military-eligible women.			
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FOREWORD

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10-06-97
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INTRODUCTION:

This proposal responds directly to the recommendations for research as outlined by the Institute of Medicine: **Recommendations for Research on the Health of Military Women**. Our proposal specifically addresses the request for research on the effectiveness of different types of physical training programs for women in the military.

Although physical activity is routinely prescribed for military-eligible women, a systematic examination of the effects of different modes of training on women's physiology and work performance has not been undertaken. Specifically, the decline in physical activity and loss of fat-free mass are significant predictors of decreased function and increased cardiovascular risk in military-eligible women. Thus, exercise interventions specifically designed to offset these deleterious changes in work performance, body composition and physical activity are important considerations. All military women initially experience the physical challenges of basic training and once through this experience, the new soldier experiences additional physical challenges that are directly influenced by other military-related activities including, deployment, natural aging, etc. Moreover, given the increased number of career military women retained in the services, strategies to achieve and maintain optimal fitness are of high priority.

Although exercise is recommended to military women, it is unclear as to which type of exercise is most effective in maintaining physical fitness and body composition in an effort to reduce cardiovascular risk and enhance physical function. This proposal will address several health benefits of endurance and resistance exercise in military eligible women in an effort to establish guidelines to maintain optimal cardiovascular and metabolic fitness in military-eligible women. **Results from this study will lay the scientific groundwork for the prescription of endurance and/or resistance exercise as the optimal mode of exercise to maintain physical fitness, work performance and reduce cardiovascular risk in military eligible women.**

The overall hypothesis is that the decline in physical activity habits and resultant increase in body fat reduces exercise capacity and muscle mass in military women. These lifestyle changes worsen metabolic and cardiovascular risk factors. Therefore, continued involvement in resistance and endurance exercise programs which increases or preserves fat-free mass will prevent functional declines in military-eligible women. Although exercise is frequently recommended to enhance overall fitness, it is unclear as to whether endurance or resistance exercise is more effective in attenuating functional and cardiovascular declines in women. We will systematically compare the effects of **endurance** and **resistance** exercise on physical activity, cardiovascular fitness, and fat metabolism in military eligible women. The results of this study will lay the groundwork for appropriate exercise prescriptions to reduce cardiovascular and metabolic risk and enhance physical function in military-eligible women.

1. AIMS AND HYPOTHESES:

AIM #1: To determine the effects of endurance exercise and resistance training on free-living physical activity and cardiovascular fitness in military-eligible women.

AIM #2: To determine the effects of endurance training and resistance training on body composition and body fat distribution.

AIM #3: To determine the effects of low intensity endurance vs resistance training on in-vivo fat metabolism and insulin sensitivity.

2. BACKGROUND AND SIGNIFICANCE

Although increased physical activity is recommended to women, it is unknown as to the type of exercise that is most effective in attenuating functional declines and improving metabolic fitness. We will directly compare the effects of **endurance** and **resistance** training on: 1) free-living physical activity and cardiovascular fitness, 2) body composition and body fat distribution; fat metabolism, and insulin sensitivity in military-eligible women.

(2a) Exercise and Energy Expenditure.

One important reason to prescribe exercise is to increase daily energy expenditure and physical activity to maintain proper levels of body weight and composition. The influence of different types of exercise to achieve this goal has not been systematically examined in women.

Are endurance and resistance exercise effective interventions to increase resting and physical activity-related energy expenditure? A compelling goal of physical training programs is to increase physical activity and energy expenditure. It is presently unknown whether training programs accomplish this goal as physical activity levels outside of the exercise program could not be accurately measured. This proposal will provide new information on the impact of endurance and resistance exercise programs on resting and physical-activity related energy expenditure.

Resting metabolic rate is the largest component of daily energy expenditure in humans (1). A low resting metabolic rate is a significant predictor for body weight gain (2), which may partially explain increases in body weight in women. We have also found the women have a lower resting metabolic rate per kilogram of fat-free mass (3). Collectively, these findings underscore the importance of exercise interventions that would increase resting energy expenditure in women in an effort to offset increases in body weight over time.

It is encouraging to noted that both endurance and resistance training has been found to increase resting metabolic rate in women (1). However, its effects on free-living physical activity is of greater interest with respect to regulation of energy balance. Changes in physical activity constitute a large proportion of variation in daily energy expenditure. Moreover, low levels of physical activity is a significant predictor of an increase in body weight over time (4).

We recently performed a study to examine the effects of endurance exercise on free-living energy expenditure outside of the exercise program. We found that women actually reduced their free-living physical activity during non-exercising time in response to endurance training (5). This physiological adaptation is counter-productive to the goals of the military which strive to increase daily energy expenditure through physical exercise. It is possible that the intense level of the exercise program (85% of VO₂ max) may have contributed to this finding. This study raises new questions regarding the optimal exercise mode to enhance free-living physical activity in women. **This proposal will provide new information on the effects of endurance exercise on free-living physical activity by administration of doubly labeled water and the subsequent measurement of free-living physical activity.**

Much interest has recently focused on resistance training as an intervention to enhance muscular strength, restore physical function and reduce cardiovascular risk (6). The impact of resistance training, however, on physical and metabolic function has received less attention than endurance training, particularly in women. Resistance training is an effective stimulus to increase muscular strength and fat-free mass in untrained adults (6). The anabolic nature of resistance training may reverse declines in resting metabolic rate by increasing fat-free mass (7,8). We have no information, however, on the effects of resistance training on free-living physical activity in women. Resistance training may enhance free-living physical activity by several mechanisms: 1) an increase in protein synthesis (9); 2) an increase in sympathetic nervous system (8) and 3) increased levels of fat-free mass. In this study, we will provide new information on the effects of endurance exercise and resistance training as therapeutic interventions to increase free-living physical activity and maintain muscle mass in military-eligible women.

(2b) Exercise, Intra-abdominal Fat and Insulin Sensitivity

What are the effects of endurance and resistance exercise on body fat distribution and insulin sensitivity? We have included in the proposal an examination of the effects of exercise on the metabolic risk factors of insulin and fat metabolism. The rationale for their inclusion is twofold: 1) changes in physical activity and body composition in response to training positively influence these variables and 2) the insulin resistance syndrome is an independent risk factor for cardiovascular (10). It is only recently, however, that the role of exercise to reduce intra-abdominal fat has been examined, and to our knowledge, no information is available in women.

Schwartz et al (11) found that a six month endurance training induced a preferential loss of fat from the abdominal region. Despite the relatively small changes in body weight (<2 kg) and body composition, impressive (>20%) decrements were found in intra-abdominal fat. These changes were associated with improved lipid lipoprotein profiles. Tonino (12) demonstrated an increase in insulin sensitivity with the euglycemic clamp technique in men following an aerobic exercise training program which did not substantially affect body composition. Houmard et al (13) exercise trained 13 middle-aged men, but found that a reduction in central body fat, as measured from the waist circumference, was not related to an improvement in insulin sensitivity. Alternatively, Kirwan et al (14) noted that regular exercise was effective in reducing hyperinsulinemia and improving insulin sensitivity and that these changes were related to the reduction in the waist circumference. Khort et al (15) showed that a higher waist circumference was related to a lower rate of glucose disposal in men. Unfortunately, no systematic investigation of the effects of exercise on insulin sensitivity and body fat distribution has been undertaken in women.

Most studies have focused on endurance training, whereas less attention has been directed towards the effects of resistance training on intra-abdominal body fat and insulin sensitivity. However, because isometric contractions produce insulin-like effects on glucose uptake in skeletal muscle (16) and muscle mass serves as the principal site of glucose disposal, resistance training could be an important intervention to enhance insulin action in women. Recent reports provide support for this hypothesis. Ross and Rissanen (17) found that the combination of energy restriction (1000 kcal/day) and either resistance or aerobic exercise induced significant reductions in intra-abdominal fat. This was a surprising finding given the fact that the direct energy cost of the endurance exercise program was substantially higher than the resistance training program. This finding suggests that changes in the other components of total daily energy expenditure (resting

metabolic rate or physical activity) may have occurred that significantly increased the total daily energy expenditure of the resistance training program.

Several investigators examined changes in insulin sensitivity in response to resistance training. For example, insulin responses to an oral glucose challenge were found to be lower in younger individuals after resistance training (18), and in some cases glucose tolerance was improved similarly in endurance and resistance training (19). Miller et al (20) showed that 16 weeks of strength training improved the insulin response to glucose ingestion in young males, which they attributed to an increased muscle mass. Data from our laboratory showed that strength training increased nonoxidative glucose metabolism by 45% in men (21). To our knowledge, no studies have directly compared the effects of endurance vs resistance training on changes in intra-abdominal body fat and associated changes in glucose metabolism in women.

(2c) Exercise and Fat Metabolism.

What are the effects of endurance and resistance exercise on fat oxidation? We feel it is important to include a measure of fat oxidation in the present study to help explain the mechanisms related to changes in insulin sensitivity. It is reasonable to hypothesize that the loss of intra-abdominal body fat with exercise training programs will be associated with improvement in insulin sensitivity. This is based on the fact that adipose tissue in the visceral region is highly sensitive to lipolytic stimuli, particularly in those regions drained by the portal circulation (22). As a consequence, increased fat oxidation as a result of exercise would reduce the delivery of free-fatty acids to the liver, thereby reducing gluconeogenesis and stimulating hepatic insulin clearance. This would lead to lower circulating concentrations of insulin and increased insulin sensitivity (23). However, the optimal exercise mode to maximize loss of intra-abdominal fat and improve insulin action has not been clearly established.

The majority of knowledge regarding the effects of exercise on fat oxidation has been primarily derived from endurance training studies and from measurements of circulating concentrations of substrates considered to be representative of lipolytic action (24,25). More recently, we have used in-vivo techniques to quantify fat metabolism in humans. We showed that endurance training increased levels of fat oxidation in healthy women (26). However, less information is available regarding the effects of resistance training on fat oxidation in younger women. Pratley et al (8) showed that 16 weeks of resistance training increased plasma levels of norepinephrine in men, but no changes were noted in fat oxidation. Melby et al (27) showed that resistance exercise elevated postexercise metabolic rate and fat oxidation 15-hr after exercise completion. They suggested that resistance exercise may be beneficial in weight control because of the direct energy cost of the activity, the residual elevation of postexercise VO_2 and the greater post-exercise fat oxidation. Work from our laboratory shows that fat-free mass is an important regulator of the rate of appearance of fatty acids into circulation and fat oxidation in women (28,29). Thus, resistance training may elevate the level of fat oxidation by increasing the metabolic demand for fatty acids by increasing skeletal muscle mass as well as the level of daily energy expenditure and physical activity. This study will provide new insight into the effects of endurance and resistance training on insulin sensitivity and fat oxidation in military-eligible women.

Collectively, this will be the first proposal to systematically examine the effects of endurance and resistance training on a comprehensive battery of cardiovascular and metabolic risk factors in military-eligible women.

3. WORK ACCOMPLISHED:

Intervention Studies

We examined the effects of exercise training on changes in total daily energy expenditure and physical activity. We subjected women to 8 weeks of intense endurance training in which resting metabolic rate, body composition and norepinephrine kinetics were measured (30,31). We found that resting metabolic rate increased by 10% (150 kcal/d), without significant changes in body composition. These results suggest that endurance training increases resting energy needs in women. These results prompted further studies with doubly labeled water to examine the effects of exercise on daily physical activity, the true determinant of energy balance. **These studies document our ability to carry out and retain women in exercise intervention studies.**

We used doubly labeled water to assess the effects of exercise on free-living energy expenditure (5). We found that individuals became more inactive during their non-exercising time in response to a high intensity endurance exercise. We found that endurance training resulted in a 62% reduction in the energy expenditure of physical activity outside of the exercise program (571 ± 383 to 340 ± 452 kcal/d). The results underscore the importance of using doubly labeled water to determine the effects of endurance or resistance exercise on daily energy expenditure in women. **This study documents our ability to use doubly labeled water methodology in exercise intervention studies and raises new questions regarding the type of exercise that is most efficient in increasing physical activity in military-eligible women.**

Fat Metabolism:

In a series of studies, the effects of endurance training on fat oxidation in women were assessed. Free fatty acid appearance rate and fat oxidation were determined from ^{14}C palmitate infusions and indirect calorimetry (26). In response to endurance training, free fatty acid appearance did not change, but fat oxidation increased (200 ± 12 vs $244 \pm 16 \mu\text{mol} \cdot \text{min}^{-1}$; $P<0.01$). These results support the notion that endurance training increases fat oxidation in the basal state. Furthermore, individuals who increased total daily energy expenditure and physical activity, also showed higher levels of fat oxidation ($r=0.55$; $P<0.05$). **These findings led us to propose to test the hypothesis that significant increases in total daily energy expenditure and physical activity (by endurance or resistance exercise) will enhance fat oxidation, promote loss of intra-abdominal fat and increase insulin sensitivity in military-eligible women.**

Resistance Training:

We examined relationships of resting metabolic rate to cardiovascular disease risk in middle-aged women characterized as resistance trained, aerobic trained or untrained (33). Resting metabolic rate, after normalization for differences in fat-free mass, was 7% higher in aerobic and resistance trained women compared to untrained women. Both aerobic and resistance trained individuals were expending approximately 200 kcal/d more at rest when compared to untrained individuals. These results suggest that resistance and aerobic training can serve as suitable interventions to offset the decline in resting metabolic rate in military women. **We now propose a resistance training study in which daily energy expenditure can be measured to assess it**

relation to enhanced functional capacity and cardiovascular risk factors in military eligible women.

The effects of resistance training, with and without weight loss, on endogenous insulin secretion and peripheral tissue glucose utilization was examined in postmenopausal women (34). Women trained three times per week for 16 weeks on resistance machines. Body composition was measured from dual-energy x-ray absorptiometry. Despite weight loss, fat-free mass was maintained in weight loss groups by concomitant resistance training. The endogenous insulin response decreased 24% with resistance training and 42% with resistance training and weight loss, with no change in glucose utilization. These results suggest that peripheral tissue sensitivity to endogenously secreted insulin improved to a greater extent with resistance training and weight loss rather than resistance training alone. However, resistance training increased insulin sensitivity in both groups. These results suggest that increased adiposity and glucose intolerance associated with the post-menopausal state could be prevented with resistance training and weight loss. **We now propose to study the mechanism of the increase in insulin sensitivity in military-eligible women by examining in-vivo fatty acid utilization and oxidation.**

Significance of Proposed Work. The adaptive responses of military-eligible women to endurance and resistance training has been an understudied area of research. The combined used of doubly labeled water methodology, multicompartment models of body composition, and substrate measures of insulin sensitivity and fat oxidation will provide new information on the effects of resistance and endurance exercise to cardiovascular and metabolic risk factors. Our preliminary data demonstrates our ability to successfully conduct exercise studies in women, perform sophisticated measured of energy expenditure and substrate metabolism. **Results from this study will lay the scientific groundwork for the prescription of resistance and endurance exercise to enhance cardiovascular and metabolic fitness in military eligible women.**

BODY OF THE REPORT:

Subject Selection: We will recruit 104 military eligible, non-pregnant women (18 to 35 yrs) over 4 years. The recruiting goal of 104 individuals takes into account a 20% dropout rate with the goal of having 28 volunteers complete the interventions (endurance, resistance and control). Volunteers will be screened by telephone to ensure that they meet study inclusion criteria and are free of exclusionary criteria. Eligible subjects will be scheduled for a screening visit at which time the study will be explained in detail and a written informed consent will be obtained. A fasting blood profile, a urinalysis, fasting and two hour postprandial glucose and a resting EKG will be obtained.

Criteria for subject inclusion will be: premenopausal and age between 18 to 35 years, a body mass index between 18 and 25 kg/m². Exclusion criteria include a history or evidence on physical examination or testing of the following: 1) diabetes; 2) orthopedic limitations or history of pathologic fractures, 3) hypertension (>160/90 mmHg; 4) use of prescription or over the counter medications which could affect glucose metabolism (including insulin and oral hypoglycemic agents), 5) smoking.

Experimental Design. Volunteers will be randomly assigned to a 6-month **endurance, resistance training or control group.** All subjects will be weight stabilized and given dietary advice to consume a diet containing at least 250g of carbohydrate per day prior to testing. Diets will not be

changed throughout the program. All tests will be performed during the follicular phase of the menstrual cycle. The testing sequence is described below:

Testing Sequence.

1. Recruiting: Telephone screen and advertising

2. Screening visit (1 day)

- (a) Physical exam and history
- (b) Graded exercise test

3. Dietary Instruction, Body Weight Stabilization (2 weeks)

(a) Two weeks of dietary instruction for body weight stabilization and adequate carbohydrate intake. Perform test of VO₂ max test during this period to avoid interference of vigorous exercise with other metabolic tests.

4. Overnight Visit to the University of Vermont (1 day)

- (a) Administration of Baseline Doubly Labeled Water (afternoon of admission)
- (b) Computerized Tomography Scan (afternoon of admission)
- (c) Resting Metabolic Rate
- (d) Dual Energy x-ray Absorptiometry Scan
- (e) Fatty Acid Kinetics
- (f) Perform Insulin Clamp

5. Return visit (10 days later)

- (a) Urine collections of doubly labeled water

6. Random assignment to Endurance, Resistance or Control group

7. Tests During Exercise Programs

- (a) Re-assessment of strength to maintain exercise prescription

8. 6 month Post-testing Period:

(a) Testing sequence is identical as described in 3, 4 and 5 (testing conducted at least 48 h after last exercise session)

METHODS

The METHODS section is subdivided into the following categories:

- (1) Endurance Training, Resistance Training and Control Group;
- (2) Energy Expenditure;
- (3) Body Composition and Body Fat Distribution;
- (4) Insulin Sensitivity
- (5) Fat Metabolism

(1) INTERVENTIONS:

(a) Endurance Training Program

All endurance exercise sessions will be preceded by a 10 min warm-up which will consist of stretching of the major muscle groups and slow walking on a treadmill. The women will exercise three times per week using the Racquets Edge Health and Fitness Center. The training sessions will consist of an individually prescribed duration and intensity. To monitor adherence to prescribed

training plan, volunteers will wear the heart rate monitor (Polar Accurex, Polar Electronics Inc.) during each training session. A warm-down will be performed after the treadmill session and will consist of flexibility exercises. Data of individuals will be considered in the statistical analysis who attend at least 80% of all exercise sessions.

The women will be taught to monitor their heart rates. The duration of the exercise will begin at ~ 20 minutes walk/jogging. By the end of the exercise program, individuals will be jogging approximately 45 to 55 minutes (Table 1). By the end of 6 months of endurance training, volunteers will be expending approximately 600-800 kcal per session, or an additional increase of 2400 to 3200 kcal per week generated by the direct energy cost of the exercise. The quantity of expenditure will be substantial but realistic to perform when an adequate adaptation period is built into the study. Dr. Dvorak (a fellow in Dr. Poehlman's laboratory) and hired personal trainers will supervise the exercise program.

Duration of exercise	Week 1	Week 2	Week 3	Week 4
25'	70%	75%	80%	85%
	Week 5	Week 6	Week 7	Week 8
30'	75%	80%	85%	90%
	Week 9	Week 10	Week 11	Week 12
35'	75%	80%	85%	90%
	Week 13	Week 14	Week 15	Week 16
40'	75%	80%	85%	90%
	Week 17	Week 18	Week 19	Week 20
45'	80%	85%	90%	
	Week 21	Week 22	Week 23	
50'	80%	85%	90%	
	Week 24	Week 25	Week 26	
55'	80%	85%	90%	

Table 1. Endurance exercise training program (70% represents the percentage of HR_{max} obtained during the peak oxygen consumption test)

(b) Resistance Training Program

The resistance training program is designed to stimulate optimal gains in muscular size and strength over the 6-month training period. Women will train on three non-consecutive days during the week (e.g., Mon, Wed, Fri). Variation in training will enhance the quality of the exercise stimulus by improving the adherence to the training program and reducing the potential boredom often associated with the use of a redundant resistance training protocol.

Women will be individually instructed in the performance of each exercise and allowed to practice the exercise and strength testing protocol several times prior to initial testing and the start of the training program. Prior to strength testing, two resistance training sessions will be conducted so that women can become familiar with the equipment and proper exercise techniques.

Each training session will include a warm-up of low intensity cycling for 5 min, followed by a 10 min of static stretching of all the major muscle groups used in training. Each exercise session will be individually monitored for optimal progression. The resistance program will consist of the following exercises: 1) Leg press, 2) Bench Press; 3) Leg Extensions; 4) Military Press; 5) Lat Pull Downs; 6) Hamstring Curls; 7) Seated Rows; 8) Triceps Extensions and 9) Biceps Curls. The exercises will provide for a total body resistance training program for all of the major muscle groups

of the body. Cybex weight training equipment (located in the Racquets Edge Health and Fitness Center) will be used.

The basic prescription is to perform three sets of ten repetitions for individual lift, with sixty seconds breaks between the sets. In addition, volunteers should exercise to the failure during the last set, more specifically, they should be able to perform at least six but no more than 12 repetitions. When they reach the level of performance so that they can reach 12 repetitions during the last set, the resistance will be increased for the next training session. This will ensure the necessary level of overload for each training session.

Because of the need for test specificity, 1 RM evaluations of certain exercises used in the training program will provide the most direct evaluation of the training gains made over the 6-month period. The 1-RM is defined as the maximum amount of resistance that can be moved through the full range of motion of an exercise for no more than one repetition. To determine the 1 RM, each subject will initially perform 3 to 5 repetitions with the lightest weight possible to be sure proper technique is used. The investigator will then select a weight and ask the subject to perform the lift. Following 3 to 4 minutes of rest, the next heaviest weight will be selected and the attempt will be repeated until the subject cannot complete the full lift. In each case, the investigator will attempt to determine the 1 RM with 6 to 7 trials to prevent localized muscle fatigue. Training will be at approximately 80% of 1 RM. The same number of trials, time between trials and order of exercises will be used before and after training for the 1-RM test. Tests will be administered prior to the start of the training program and twice per month for the first two months (because of the anticipated rapid increase in strength) and once per month thereafter. The following exercise will be evaluated for 1 RM's: leg press, leg extension, bench press, military press, lat pull downs and seated rows.

(c) Control Group

The attention control group will meet as frequently in a group as the exercise intervention groups at the University of Vermont. They will be strongly encouraged to maintain their current level of physical activity and not to engage in any form of endurance or resistance exercise. They will receive similar dietary instruction and social support as the exercise intervention groups. They will participate in all testing and weight stabilization. Following the completion of the study, these women will be provided personalized exercise prescriptions for endurance and resistance training programs.

(2) ENERGY EXPENDITURE

(a) Doubly labeled water (DLW).

To determine the effects of endurance and resistance training on changes in daily energy expenditure and physical activity, energy expenditure will be measured during a 10-day period using DLW methodology (32). A baseline urine (10 ml) will be collected and a mixed dose of DLW will be orally administered the afternoon before the first test visit. The doses will be approximately 0.24g of H₂¹⁸O and 0.22g of ²H₂O per kg of estimated total body water. The dose described has been selected to achieve initial and final enrichments that translate, by propagation of error analysis to a theoretical uncertainty in carbon dioxide production rates arising from analytical error of less than 5% (32).

Two urine samples will be collected on the morning after dosing, and another two will be collected on a return visit 10 days later. Samples will be analyzed in triplicate for H₂¹⁸O and ²H₂O enrichments by isotope ratio mass spectrometry at the Biomedical Mass Spectrometry Facility in the

Department of Medicine at the University of Vermont using the CO₂ equilibration technique (36), and the off-line zinc reduction method (37). Total daily energy expenditure will be calculated from doubly labeled water data using equation A6 of Schoeller et al (38). **This technique will provide new information on whether physical activity levels (outside of the exercise programs) change in response to the endurance and resistance exercise programs.**

(b) Resting Metabolic Rate (RMR).

RMR will be assessed after an overnight fast in which volunteers will stay overnight. RMR will be measured for each subject by indirect calorimetry for 45 min, using the ventilated hood technique (39). Energy expenditure will be calculated from the equation of Weir (40). The intraclass correlation and coefficient of variation (CV) for RMR determined using test-retest in 17 volunteers is 0.90 and 4.3%, respectively. **This measurement provides information on whether resting energy requirements change in response to endurance and resistance exercise.**

(c) Physical Activity Energy Expenditure.

The energy expenditure of physical activity will be derived by subtracting RMR, and an estimate for the thermic effect of a meal from total daily energy expenditure (32). A fixed constant of 10% of daily energy expenditure for the thermic response to feeding will be assumed (41). We have chosen not to directly measure the thermic effect of a meal because: 1) its contribution to total daily energy expenditure is small (10% of total daily energy expenditure) (42) and 2) postprandial measurements are long (4 to 6 hr) and of questionable reproducibility (43) and 3) the measurement of postprandial energy expenditure would significantly increase the time commitment for the women. **The change in the level of physical activity is a primary outcome variable because of its large contribution to daily energy expenditure and its relationship to changes in body composition.**

(d) Maximal Aerobic Power (VO₂ max).

VO₂ max will be assessed by a progressive and continuous test to exhaustion on a treadmill. VO₂ max will be considered to have been achieved if two of the following criteria are met: 1) a plateauing of VO₂ when the increase in oxygen consumption during the last minute of the VO₂ max test is <200 ml; 2) a respiratory exchange ratio greater than 1.1; or 3) a heart rate at or above the age-related predicted maximum (220 - age, yr). Test-retest conditions (within 1 week) for VO₂ max for 20 volunteers have yielded an intraclass correlation of 0.94. If these criteria are not met, we will request that the volunteer perform another test of VO₂max. VO₂ max will be assessed every two months to take into account the increases in maximal aerobic power so that exercise prescriptions can be re-evaluated to maintain the desired exercise intensity.

(d) Estimated energy intake.

Self-recorded energy intake will be measured for seven days during the doubly labeled water measurement period. Briefly, volunteers will be provided with record sheets and dietary scales including procedures for reporting intake, estimation of portions, and describing food combinations. The energy content from food diaries will provide a more accurate estimate of food quotient necessary in the calculation from doubly labeled water.

(3) BODY COMPOSITION AND BODY FAT DISTRIBUTION

(a) Dual Energy x-ray Absorptiometry (DEXA)

DEXA uses the exponential attenuation due to absorption by body tissues of photons emitted at two energy levels (40 and 70 keV) to resolve body weight into bone mineral, and lean and fat soft tissue masses. The subject will lie supine on a padded table. All metal objects will be removed. The total dose for a scan is less than 1mSv. A total body scan takes about 30 minutes and provides estimates of the following: bone mineral densities (BMD, g/cm²), soft-tissue attenuations ratios (Rst-values), fat and lean tissue weights (g), and percent body fat for 9 body regions, as well as total body fat weight, %body fat, fat-free mass and total body mineral weight. The reproducibility for body fat is 1.7% in test-retest conditions in six females. **This technique provides information on whether fat mass, fat-free mass and bone density changes in response to endurance and resistance exercise.**

(b) Computerized tomography (CT).

CT scans are performed on a Siemens Somatom DRH scanner (Erlangen, FRG) using the procedures of Sjostrom et al (44). Briefly, women are examined in the supine position with both arms stretched above their head and single 5 mm, 2 second scans are taken at the abdomen at the level of the umbilicus and the mid-thigh level halfway between the greater trochanter and superior aspect of the patella and greater trochanter. Based on our evaluation of mean attenuation and intersection of adipose muscle tissues of over 400 cross-sections of intra-abdominal adipose tissue, a range of -190 to -30 Hounsfield units (HU) are used to measure cross-sectional area of adipose tissue and 30-80 HU for muscle tissue. Intra-abdominal and subcutaneous fat areas (expressed in cm²) are measured using an automated computer program which outlines fat with the HU range selected. The coefficient of variation for repeat cross-section analysis of scans among 40 women is less than 2% for adipose tissue. **The technique will provide information on whether the quantity of visceral fat changes in response to resistance and endurance exercise.**

(3) INSULIN SENSITIVITY

The hyperinsulinemic/euglycemic clamp will be used to measure sensitivity to insulin (23). Women will have an intravenous catheter placed in a large antecubital vein for infusion (20% dextrose) and another placed in a retrograde fashion into a dorsal vein with the hand kept in a warming box at 70°C to arterialize venous effluent. Blood samples are drawn from the dorsal hand vein for glucose and insulin determination (every 5 min). Plasma glucose levels are measured (Beckman Instruments, Fullerton, CA) and the rate of glucose infusion adjusted every 5 minutes to maintain the desired level of glycemia. Insulin concentrations will be measured by radioimmunoassay in all samples from an individual (baseline, and post-intervention) in a single assay to minimize interassay variation.

The amount of glucose utilized is an index of insulin sensitivity. **This technique will provide new information on changes in insulin sensitivity in response to endurance and resistance exercise in military-eligible women.**

(4) FAT METABOLISM

i. **¹³C-palmitate kinetics:**

Basal rates of lipolysis and whole body fat oxidation will be assessed as previously described (26). Briefly, a non-primed constant infusion of [1-¹³C]palmitic acid will be administered for 120 min in the post-absorptive state with simultaneous measurement of resting metabolic rate with indirect calorimetry. Samples for determination of the enrichment of the specific activity of palmitic acid will be taken prior to and at 90, 100, 110, and 120 min after the start of the infusion.

The calculations will be made using the following equations:

i. The rate of appearance of palmitic acid (R_{aP}) with the following formula:

$$R_{aP} (\mu\text{mol}/\text{kg}/\text{min}) = IR / IE$$

where, **IR** is the infusion rate of tracer ($\mu\text{mol}/\text{kg}/\text{min}$) and **IE** is the enrichment of substrate in plasma at isotopic equilibrium.

ii. The rate of appearance of free fatty acids (R_{aFFA}) with the following formula:

$$R_{aFFA} (\mu\text{mol}/\text{kg}/\text{min}) = R_{aP} (C_{FFA}/C_P)$$

where, **C_{FFA}** is a concentration of free fatty acids in the blood measured by colorometric assay using kit from Biochemical Diagnostics (Brentwood, NY) and **C_P** is the concentration of plasma palmitate measured by gas chromatography-mass spectrometry.

iii. The rate of oxidative disposal (FFA_{ox}) of serum fatty acids will be measured by indirect calorimetry. The rate of fat oxidation (FAT_{ox}) is obtained by dividing fat oxidation calculated with indirect calorimetry by 860 (molecular weight of a typical triglyceride), and multiplying it times three (three fatty acids per mole of triglyceride).

iv. The rate of non-oxidative disposal (FFA_{NOX}) of serum fatty acids (extracellular recycling of fatty acids by the following formula:

$$FFA_{NOX} = R_{aFFA} - FFA_{OX}$$

The coefficient of variation for test-retest measurements is 13% and the intra-class correlation is 0.95 for ten older individuals tested two weeks apart. **This technique will provide information on changes in fatty acid appearance and fat oxidation in response to endurance and resistance exercise programs in military eligible women.**

(5) SAMPLE SIZE CALCULATIONS and DATA ANALYSIS

(1) Sample Size Calculations

We have calculated sample sizes based on hypothesized changes within the endurance and resistance treatment conditions. We present power calculations for hypothesized changes in two variables: 1) total daily energy expenditure and 2) insulin sensitivity. Our sample size calculations are for an alpha level of 0.05 with 80% power. Our recruiting and sample size goals were finally based on the changes anticipated with insulin sensitivity because of the larger sample size required.

We hypothesized that the total daily energy expenditure will be increased by 360 kcal/d for both endurance and resistance training with a standard deviation of 200 kcal/d in women. This increase takes into account the 10% increase in resting metabolic rate (160 kcal/d) (30) and the hypothesized increase of 200 kcal/d in free-living physical activity. We anticipate that endurance exercise will increase physical activity during non-exercising time because: 1) the loss of fat mass will reduce the burden of carrying extra weight and 2) daily physical activities will be performed at a lower percentage of $VO_2\text{max}$. We anticipate that resistance training will increase fat-free mass by 2-3 kg. Data from our laboratory shows that for each 1 kg increase in fat-free mass, resting metabolic rate increases by approximately 50 kcal/d (42). This would translate into a 150-160

increase in resting metabolic rate per day. Again, given the increase in fat-free mass, we anticipate that women will be more physically active and expend approximately 200 kcal/d more per day in their non-exercising time. Thus, we hypothesize that total daily energy expenditure will be increased by an extra 360 kcal/d with a standard deviation of 200 kcal/d (32).

We have also performed power analyses on changes in insulin sensitivity. We estimated that setting the power at 0.80 and a significance level at 0.05, in order to detect a difference in glucose utilization 0.4 mg/kg fat free-mass/min. This preliminary data from our laboratory is based on 0.8 mg/kg fat-free mass change in glucose utilization in 10 endurance trained individuals who trained for 6 months and a 0.4 mg/kg fat-free mass change in 12 older individuals who lost 4 kg after 6 months and with a standard deviation of 1.1 and 1.3 mg, respectively. We will need 85 subjects or 28 women per group (resistance, endurance and control). With a 20% dropout rate, we will need to recruit 104 women over the four year grant period. Because the sample size calculations for this variable yielded the greatest number of subjects to be recruited, we have based our recruiting and sample size calculations on the change in insulin sensitivity.

(b) Statistical Analysis

Analysis: A repeated measures analysis of variance will be used to detect changes with time within the treatment condition and among groups (endurance vs resistance vs control). The repeated measures factor will be the repeated tests during the exercise programs.

This analysis will provide information on whether total daily energy expenditure, resting metabolic rate, physical activity, fat metabolism and intra-abdominal body fat and insulin sensitivity change in response to and among treatment conditions. Changes in the dependent variables will be analyzed on an absolute as well as relative (%) basis.

RESULTS:

To date we have screened over the phone more than 200 women for the study. From those, 74 volunteers met inclusion and exclusion criteria and were invited for the screening visit at the Clinical Research Center (CRC). There are no statistically significant differences among the groups.

Variable	Group →	Endurance (n = 19)	Resistance (n = 18)	Control (n = 19)
Age (yr.)	Mean ± SD	29 ± 4	28 ± 4	28 ± 5
	Range	23 – 35	23 – 34	20 – 35
Height (m)	Mean ± SD	1.64 ± 0.06	1.65 ± 0.08	1.64 ± 0.08
	Range	1.55 – 1.77	1.49 – 1.78	1.51 – 1.75
Weight (kg)	Mean ± SD	61.0 ± 7.0	58.2 ± 8.8	58.8 ± 7.8
	Range	51.7 – 81.5	40.1 – 83.0	46.2 – 78.0
Body mass index (kg/m²)	Mean ± SD	22.7 ± 1.7	21.4 ± 2.3	21.8 ± 1.8
	Range	20.1 – 26.1	18.0 – 26.3	19.1 – 25.5
Peak VO₂ (ml/kg/min)	Mean ± SD	39.5 ± 7.5	38.8 ± 6.5	40.3 ± 6.6
	Range	26.6 – 53.1	27.8 – 51.5	27.8 – 53.4

Table 1: Physical characteristics of volunteers

To date, 56 women were invited for the first overnight visit at the CRC. Their physical characteristics are presented in Table 1. Results of measurements conducted during this visit, which were available at the time of preparation of this report, are presented on the enclosed spreadsheet (Appendix 1).

Starting in February 1997, volunteers began exercising in the Racquets Edge Health and Fitness Club using the exercise prescription described previously. To date, we have had 19 volunteers in the endurance training group, 18 in resistance training group, and 19 in the control group. So far, five members of the endurance-training group, three of the resistance-training group, and three of the control group have returned for the second overnight visit. Available results from the second overnight visit are presented in enclosed spreadsheet (Appendix 1). We are unable, at this point, to make any comparisons, since we do not have large enough sample size. Moreover, the results for two primary outcome variables, total daily energy expenditure (doubly labeled water) and fat oxidation (^{13}C -palmitic acid) are not available at this time, because of the labor-intensive nature of analyses involved. Furthermore, to reduce "intra-assay" variance, we analyze the pre- and post-intervention samples together, and since the first group of volunteers is being re-tested during the preparation of this report, we have not initiated analyses at this point.

DISCUSSION:

We concluded that our randomization procedure was successful, since there were not any statistically significant differences among the groups at pre-testing in any of the physical characteristic variables. Moreover, we have been successful in recruitment and retention of volunteers.

The training proceeds as planned, without any major problems. Some of the participants had to drop out from the study because of health problems related to the prescribed exercise, such as knee pain and "shin splints." This is to be expected, since only previously sedentary women are accepted for participation. Furthermore, several participants had to drop out of the study because they moved out of the area or their jobs changed so that they were not able to come to the exercise facility during designated times. Lastly, one of the participants became pregnant. Overall, the dropout rate is 16 %, which is within the anticipated range (20%).

RECOMMENDATIONS:

We do not have any recommendations at this time, because for reasons discussed above the results from primary outcome variables are not available at the time of preparation of this report.

CONCLUSIONS:

We are very pleased with the progress of the study. We were able to recruit a substantial cohort of young women and the composition of all three groups follows the inclusion criteria as outlined above. Moreover, absence of significant difference among the groups at the pre-testing in age, weight, height, body mass index and peak oxygen consumption indicates that our randomization procedure works as anticipated. We have been receiving a positive feedback from volunteers in the exercising groups and the dropout rate is below predicted level. Overall, we conclude that every aspect of the study proceeds as proposed in our original application and that we will be able to finish the project in the anticipated time.

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APPENDIX I

LAST NAME	FIRST NAME	MRR#	DOB	Phone-h.	Phone-w.	Address	Age	Group	Start
Abell	Susan	309-288-9	01/31/68	482-2728	879-0943	RR2 Box 1131, Hainsburg, VT 05461	29	1	7/23
Alberts	Hetaher	606-773-0	10/17/72	878-7761	244-8786	765 Gentes Rd., Essex Jct., VT 05452	24	2	5/28
Basset	Lynda	115-200-8	02/16/75	865-3990	n/a	103 N.Winooski Av.,B.,VT,05401	22		
Blaklock	Jennifer	552-963-1	05/25/63	899-1170		RR1 Box 3891, Jericho, VT 05465	33	3	5/19
Boe	Mary Beth	164-903-7	01/27/70	655-4190	862-6576	9 Anita Ct., Winooski, 05404	27	2	5/9
Bognar	Janina	140-685-9	03/13/75	864-3307	n/a	132 Colchester Av., B.,VT 05401	22	3	6/9
Boucher	Ann	757-999-0	11/25/65	223-2736	728-6313 e.508	8 Forrest Hill Dr., St.Alb,05478	31	3	3/20
Boyd	Kristen	150-460-4	03/26/71	878-8626	479-4363	PO Box 2031, Colchester, VT 05449	26	2	6/18
Brennan	Kasara	342-290-4	05/19/75	865-7808	658-0001	388 College St., B., VT	21	3	2/17
Briee	Whitney	105-125-9	11/12/66	863-2895	656-5566	76 Park St., B., VT	30	1	2/26
Brightman	Heidi	209-956-2	02/18/69	879-4371	654-3770 ext:337	6 Chestnut Ln #11,Colch., VT 05446	28	2	5/28
Brochu	Kara	583-972-5	11/23/62	863-5314	863-1315	1 Sdropouth Bay Cir, Colch., VT 05446	34	2	6/30
Brown	Anna	853-647-6	01/22/63	864-5204		59 Simpson Ct., B., VT	34	2	3/10
Bruce	Jennifer	356-196-6	05/10/74	879-3380	n/a	30 Sand Rd, Colch., Vt	23	2	3/21
Caldwell	Paige	560-388-1	05/11/65	985-5731	656-3222	70 Locust Hill, Shelburne, 05482	31	2	3/10
Carlson	Kristin	082-883-9	06/04/67	658-5325	6-2452 eve.	88 Pittkin St.#1, B., VT 05401	29	3	5/12
Casale	Leanne	346-106-8	07/13/71	658-0258	656-3603	CRC research kitchen	25	1	3/3
Cass	Wendy	331-137-0	10/13/70	482-6123		RR2 Box296.5, Hainsburg, VT	26	3	2/27
Chase	Lynette	124-198-3	08/23/63	899-1949	660-1508	RR2 Box 238A, Jericho, VT 05465	33	3	8/11
Chicoine	Kim	257-534-8	10/18/65	865-9178	863-6376	2301/2 N.Champlain St.,B.,Vt 05401	31	1	5/18
Chiu	Cynthia	790-864-3	12/03/76	865-4007	n/a	132 Colchest. Ave. #2, B.,	20	3	3/31
Cutter	Susan	128-225-0	07/14/73	863-7900	n/a	76 High St, Biddeford, ME 04005	23	2	3/3
Descoeteaux	Maureen	149-451-7	05/03/63		878-1456	16 Hidden Oak Dr., Colch., VT 05446	33	1	5/19
Elliott	Farar		07/28/65				32		
Gagné	Havalah	631-031-2	09/11/73		244-8788	5 Sugartree Ln.,Essex Jct., 05452	24	3	
Gallo	Michelle	329-419-6	02/16/75	879-3480		11 Wolcott St.,Colch.,05446	22	1	10/6
Gear	Amy	589-810-1	06/10/66	862-2496		76 Crescent Beach Dr.,B.,VT	31	2	
Geelmuyden	Jenifer	280-383-1	11/05/69	860-0651	656-8497	220 River Side Av.,B., VT 05401	27	3	
Grennon	Gertrude	597-438-1	06/28/72	655-4399	656-2880	251 James Ave., B., VT	24	1	4/9
Hanson	Sara	155-220-7	09/15/71	655-4953	656-2060	1005A Ethan Allen Av., Colch., 05446	25	1	2/17
Johnson	Mitzi	326-005-6	11/18/70	372-4690	n/a	PO Box 144, Hero, VT 05486	26	1	6/13
Joy	Dierdra	178-042-8	11/29/63	656-0028	863-2477	98 Lake View Terr. #1, B.,VT	33	1	
Ladd	Donna	594-809-6	01/20/69	879-2012	872-0924	82 Millpond Rd., Colch., VT 05446	28	2	6/23
Llauger	Giannina	154-711-6	05/12/73	879-4560	n/a	500 S.Prospect St. #73, B., VT	23	1	2/24
MacLachlan	Catherine	373-557-8	11/27/71	864-3529	863-7153	49 Ward St.,B.,VT 05401	26	2	6/16
Mariand	Dawn	512-239-5	09/02/62	434-5959	951-6593	PO Box 179, Richmond, VT 05477	34	1	6/1

Status	Code #	Geno	Follow-up	height1	weight1	BMI1	height2	weight2	BMI2	BMD total (g/cm3)	BMD total 2
dropout	460	11		166.0	67.7	24.6				1.205	
dropout	442	12		169.9	55.5	19.2				1.160	
control	448	11		162.0	52.5	20.0				1.160	
control	443	11		166.2	55.9	20.2				1.216	
control	464	11	m. 8/20	163.0	55.0	20.7				1.135	
done			9/8	152.0	50.0	21.6	152.0	49.5	21.4	1.229	
control	452	11		163.6	59.3	22.2				1.140	
control	317	11	8/12	171.4	57.5	19.6				1.182	
done				166.0	65.0	23.6				1.172	
dropout	455	11		170.2	59.9	20.7				1.108	
dropout	474	11		151.0	58.2	25.5				1.284	
done				173.2	58.1	19.4	172.8	60.9	20.4	1.180	1.231
dropout	272	11		177.8	83.0	26.3				1.287	
control	447	11	8/20	168.0	54.0	19.1				1.047	
done	310	11		165.4	63.9	23.4	165.4	65.2	23.8	1.170	1.196
done	296		done	165.0	54.1	19.9	164.4	51.2	18.9	1.226	1.238
dropout	458	12	8/11	154.6	50.4	21.1				1.155	
control	444	11		171.6	59.3	20.1				1.185	
control	314	12	9/2	156.3	58.3	23.9				1.146	
done	311, 491	11	done	156.6	53.0	21.6	156.0	56.7	23.3	1.130	1.141
done				176.6	81.5	26.1				1.197	
	509			164.8	64.2	23.6					
	490			162.4	56.7	21.5				1.156	
	506			159.0	55.2	21.8					
	504			149.2	40.1	18.0				1.114	
				151.4	46.2	20.2				1.159	
				161.2	56.6	21.8				1.154	
dropout				164.0	67.2	25.0				1.170	
	456	11		167.0	59.7	21.4					
				163.0	55.4	20.9					
	459	11		162.4	60.4	22.9				1.176	
	232	12		163.4	54.0	20.2				1.245	
	467	11		158.6	58.8	23.4				1.224	
	438			164.4	60.0	22.2				1.002	

BMC tot (g)	BMC tot 2	BMC trunk	BMC trunk2	BMC arms	BMC arms2	BMC legs	BMC legs2	BMC perif	BMC perif2	BMD spine	BMD spine2	BMD pelvis
2805	888	320		928		1248		0	1.347		1.071	
2480	811	321		838		1159		0	1.145		1.228	
						0		0				
2497	779	335		809		1144		0	1.164		1.070	
2735	952	350		929		1279		0	1.313		1.343	
2441	783	300		857		1157		0	1.111		1.026	
2233	2198	677	744	265	258	752	738	1017	996	1.196	1.221	1.075
2508	774	345		824		1169		0	1.143		1.115	
2744	900	305		1069		1374		0	1.145		1.221	
2744	915	332		992		1324		0	1.175		1.098	
2530	879	316		862		1178		0	1.189		1.138	
2568	926	297		875				0	1.212		1.272	
2855	2969	942	938	359	375	950	1027	1309	1402	1.274	1.467	1.152
2349	772	276		761		1037		0	1.142		1.047	
3373	1169	389		761		1150		0	1.470		1.242	
2131	627	267		751		1018		0	0.941		0.964	
2620	2764	851	938	331	338	761	908	1092	1246	1.216	1.289	1.157
2647	2667	860	853	352	339	761	908	1113	1247	1.219	1.138	1.119
2137	706	264		729		993				1.116		1.121
2726	946	344		931		1275				1.402		1.163
2456	859	288		761		1049				1.186		1.139
2116	2191	726	786	265	276	761	702	1026	978	1.062	1.260	1.152
2967	1062	381				1024		1405	0	1.395		1.252
								0				
2543	842	324		885		1209		0	1.160		1.159	
								0	0			
								0	0			
1932	583	217		638		855		0	0.971		0.980	
2503	861	333		761		1094		0	1.255		1.205	
2772	951	331		761		1092		0	1.246		1.075	
2376	713	270		938		1208		0	1.048		1.091	
						0		0				
2516	857	359		787		1146		0	1.197		1.129	
2528	792	304		761		1065		0	1.127		1.130	
2558	895	306		879		1185		0	1.345		1.267	
2098	648	265		716		981		0	0.859		1.010	

LTM trunk	LTM trunk	LTM arms	LTM arms2	LTM legs	LTM legs2	LTM per.	LTM per.2	Total m. mass	Total m. mass2	FM trunk	FM trunk2
18.46		4.40		14.58		18.98	0.00	25.31	0.00	9.60	
16.65		4.47		14.08		18.55	0.00	24.73	0.00	5.26	
						0.00	0.00	0.00	0.00		
17.45		4.33		13.37		17.70	0.00	23.59	0.00	3.82	
18.04		4.46		13.27		17.73	0.00	23.64	0.00	6.08	
18.74		4.40		14.47		18.88	0.00	25.17	0.00	4.62	
15.98	17.57	3.76	3.48	11.88	10.87	15.64	14.35	20.85	19.14	6.04	6.52
18.02		4.74		12.81		17.56	0.00	23.41	0.00	7.89	
20.86		4.91		17.91		22.82	0.00	30.42	0.00	2.34	
21.47		4.87		16.67		21.54	0.00	28.72	0.00	6.18	
17.98		4.43		14.04		18.46	0.00	24.62	0.00	6.46	
19.18		4.17		13.05		17.22	0.00	22.96	0.00	7.52	
19.69	18.93	4.92	5.24	15.64	15.89	20.56	21.13	27.41	28.18	3.53	4.49
20.08		4.14		12.60		16.74	0.00	22.32	0.00	3.85	
23.24		5.34		16.28		21.63	0.00	28.83	0.00	14.30	
17.17		4.08		13.33		17.41	0.00	23.21	0.00	4.25	
19.36	20.25	4.63	4.69	13.36	12.86	17.99	17.55	23.99	23.39	8.36	10.53
19.22	18.07	4.21	3.79	12.73	12.28	16.94	16.07	22.59	21.42	4.95	4.66
17.51		3.89		12.29		16.18	0.00	21.57	0.00	4.69	
18.97		4.33		14.96		19.29	0.00	25.72	0.00	5.74	
18.70		4.32		14.07		18.39	0.00	24.51	0.00	6.75	
17.41	18.25	3.64	4.31	11.80	11.97	15.43	16.28	20.58	21.70	6.38	6.70
25.00		5.76		14.80		20.57	0.00	27.42	0.00	15.96	
						0.00	0.00	0.00	0.00		
19.46		4.27		14.81		19.08	0.00	25.44	0.00	4.00	
						0.00	0.00	0.00	0.00		
14.70		2.85		8.28		11.13	0.00	14.84	0.00	7.60	
18.13		4.28		12.34		16.62	0.00	22.16	0.00	7.23	
19.86		4.64		15.32		19.96	0.00	26.62	0.00	8.88	
21.88		4.44		21.88		26.31	0.00	35.08	0.00	4.38	
18.56		5.17		13.67		18.83	0.00	25.11	0.00	6.65	
17.21		3.93		11.22		15.15	0.00	20.20	0.00	6.50	
19.73		4.38		14.25		18.63	0.00	24.84	0.00	6.91	
19.42		4.16		12.42		16.58	0.00	22.10	0.00	8.51	

FM arms	FM arms2	FM legs	FM legs2	FM per.	FM per.2	max l/min	max l/min2	max/kg	max/kg2	max hr	max hr2	max RQ
2.34		10.14		12.47	0.00	1800		26.59		180		1.05
1.22		7.73		8.95	0.00	1540		27.80		192		1.15
				0.00	0.00							
0.96		5.98		6.94	0.00	2010		38.80		180		1.13
1.89		6.18		8.07	0.00	1960		35.10		182		1.22
0.77		5.24		6.01	0.00	2010		36.55		211		1.13
1.43	1.11	4.66	4.14	6.10	5.25	2140	2020	42.80	40.80	200	206	1.13
1.94		7.04		8.98	0.00	1920		32.38		200		1.16
0.61		4.30		4.91	0.00	3102		53.95		206		1.13
1.45		6.74		8.19	0.00	2882		44.34		188		1.14
2.35		8.34		10.69	0.00	2870		47.91		193		1.14
0.99		6.85		7.85	0.00	2400		41.24		201		1.15
1.26		6.27	6.34	7.53	6.34	2074	not avail.	35.70	not avail.	195	not ava.	1.21
0.90		4.14		5.05	0.00	2693		51.49		193		1.22
3.43		10.46		13.89	0.00	3079		37.10		180		1.15
1.47		7.70		9.17	0.00	1940		35.93		208		1.09
1.98	2.37	6.23	6.75	8.21	9.13	2371	2279	37.00		212	206	1.12
1.23	1.04	4.48	4.34	5.71	5.38	2537		46.90		190		1.17
1.38		4.32		5.70	0.00	1820		36.11		191		1.12
1.26		7.17		8.43	0.00	2400		40.47		184		1.13
1.03		5.75		6.78	0.00	2775		47.60		196		1.16
1.14	1.62	6.62	7.35	7.77	8.97	2282	2111	42.10	37.90	210	199	1.12
3.82		9.99		13.81	0.00	2280		27.98		173		1.19
					0.00	2735		42.60		189		1.10
0.90		5.12		6.02	0.00	2500		44.10		190		1.18
				0.00	0.00	1967		36.50		196		1.18
				0.00	0.00	1885		47.00		188		1.19
1.60		4.54		6.14	0.00	1779		38.50		213		1.04
1.62		6.82		8.44	0.00	2406		42.51		197		1.13
2.41		8.98		11.39	0.00	3051		45.40		190		1.20
0.84		5.71		6.54	0.00	3170		53.10		195		1.14
				0.00	0.00	2554		46.10		201		1.15
1.66		7.23		8.89	0.00	1880		31.13		184		1.09
1.39		6.73		8.11	0.00	1831		33.90		193		1.22
1.90		5.94		7.84	0.00	2190		37.24		192		1.15
1.58		7.66		9.24	0.00	1710		28.50		171		1.21

max RQ2	LTA	LTA2	V02	V02-2	VCO2	VCO2_2	RMR kcal/d	RMR kcal/d2	RQ	RQ2	M-abs.	M-abs.
1.23			206.0		176.0		1420.0		0.85		642.9	
			207.0		166.0		1400.0		0.80		341.6	
			183.0		166.0		1270.0		0.91		365.4	
			185.0		158.0		1270.0		0.86		325.9	
269	194.0		160.0		1320.0		0.82				344.3	
1.10	388		176.0	171.0	159.0	1200.0	1190.0	0.83	0.93	503.3	504.0	
			179.0		151.0		1220.0		0.85		305.7	
			236.0		191.0		1610.0		0.81		505.9	
281			235.0		181.0		1580.0		0.77		451.3	
			225.0		191.0		1540.0		0.85		377.0	
443	170.0				152.0		1180.0		0.89		395.4	
not avail.	605		223.0	228.0	185.0	189.0	1530.0	1560.0	0.83	0.83	522.7	492.0
			164.0		146.0		1130.0		0.89		328.1	
406			222.0		193.0		1540.0		0.87		298.7	
			184.0		150.0		1250.0		0.82		592.4	
1.09	345	163	196.0	207.0	160.0	176.0	1330.0	1420.0	0.82	0.85	191.4	209.9
			217.0	211.0	166.0	176.0	1460.0	1440.0	0.77	0.84	353.3	
			150.0		132.0		1030.0		0.88		336.1	
527	196.0				168.0		1350.0		0.86		375.9	
370	187.0				165.0		1290.0		0.88		458.9	
1.10	316	199	191.0		156.0		1300.0		0.82		458.1	
			244.0		220.0		1700.0		0.90		610.4	
704			202.0		166.0		1380.0		0.82		530.9	
			177.0		157.0		1230.0		0.88		246.1	
											379.4	
			161.0		136.0		1115.0		0.85		219.0	
478	195.0				165.0		1340.0		0.85		482.0	
790	181.0				166.0		1260.0		0.92		66.9	
			203.0		164.0		1380.0		0.81		481.0	
5116	188.0				161.0		1290.0		0.85		489.0	
724	181.0				151.0		1230.0		0.84		303.4	406.0
256		201.0			163.0		1360.0		0.81		411.9	
604	187.0				171.0		1300.0		0.91		414.4	

M-FFM	M-FFM2	waist (cm)	hip (cm)	Chol. 1	Trig. 1	HDL	LDL	Chol/HDL	insulin 0	insulin 120	glucose 0	glucose 120
16.04		158	58	64		2.47			99		102	
9.12		251	236	63	141	3.98			73		77	
#DIV/0!		172	196	65	68	2.65			77		130	
9.74		199	49	73	16	2.73	< 5	13	82		78	
8.53		172	134	48	97	3.58			72		69	
8.51		157	107	43	93	3.65	11	94	79		81	
14.60	14.62	176	81				<5	11	70		51	
7.95		193	174	41	117	4.71			38		77	
10.91		137	115				<5	63	78		89	
9.79		159	93				<5		80		76	
9.81		217	117	65	129	3.34			76		101	
10.28		163	68	52	97	3.13			53		79	
12.16	11.25	157	63				6	53	82		73	
8.23		118	79				8	37	75		73	
6.28		196	47				7	41	85		76	
16.10		167	117	47	97	3.55			82		87	
4.74		167	119				12	65	82		79	
8.97		165	91				7	18	83		64	
9.29		167	126	34	108	4.91			89		77	
9.31		144	82	52	76	2.77			76		73	
11.50		165	111				7	39	87		71	
13.04		189	188				10	49	85		88	
12.69		228	138	53	147	4.30			94		79	
									91		75	
12.87		133	62	50	71	2.66			83		104	
#DIV/0!		177	71	52	111	3.40			76		114	
#DIV/0!		153	52	66	77	2.32			70		57	
7.76		204	88	60	126	3.40						
12.90		184	106						87		104	
1.59		206	105				5	27	74		62	
10.56		155	45	61	85	2.54			76		67	
#DIV/0!		166	61	59	95	2.81			80		102	
9.47		146	76	49	82	2.98	5	8	84		79	
8.63		153	110				9	23	80		88	
10.03		162	71	71	77	2.28			64		87	
10.84		141	53						80		124	

Mason	Carol Lee	356-963-9	09/21/61	899-2998	879-0943	RR2 Box 263A, Jericho VT 05465	35	3	6/16
Matthews	Stacey	887-615-3	05/11/70	660-2477	860-3441	350 Spear St.,Sdropouth B., 05403	27	2	
McKenny	Heather	677-561-3	02/19/68	863-2794	n/a	54 B Hayward St.,B.,VT	29	3	4/25
Meunier	Sharyn	207-679-2	10/04/63	933-2700	658-1128 e.29	RO1 Box 5675, Enosburg, 05450	33		
Mills	Jennifer	279-872-6	12/10/70	864-7625	860-3859	141 Hinesburg Rd., S.B., 05403	26	1	3/3
Moirano	Kimberley	890-420-3	04/17/62	863-7916	658-4300	15 Oak Creek Dr., S. BurI., VT 05403	35	1	5/30
Moreno	Joan	230-051-5	02/05/65	658-5154	658-0500	253 S.Winooski Ave.,B., VT	32	1	6/16
Morgan	Elizabeth	355-835-0	09/02/69	863-5891	60 University St.,B., VT	28			
Nieves	Yanaris	355-090-2	01/01/74	879-4560	n/a	500 S.Prospect St. #73, B., VT	23	2	2/24
Olnstead	Jennifer	354-224-8	08/26/68	862-8942	n/a	403 ColchesterAv #2, B., VT	28	3	3/17
Padnos	Rebecca	656-201-1	08/18/63	864-0214	n/a	32 Spruce Ave., B., VT 05401	33	1	6/20
Previs	Lisa	104-806-5	04/30/71	862-3255	651-8330	1412 N.Ave., B., VT 05401	25	1	5/7
Quick	Denise	139-465-9	07/02/62	658-2244	n/a	76 Hayward # 76, B., VT	34	2	3/12
Randall	Erin	366-196-4	05/01/75				22	3	8/1
Roddy	Margaret	023-722-2	10/16/63	425-4046	656-2834	1374 Louise Cr. Rd, Charlotte 05445	33	3	3/28
Ruesink	Adreana	150-602-1	08/20/70	862-2676	6-0423	280 S. Winooski Av., B., VT	26	1	3/23
Sarabia	Paige	610-339-9	12/08/72	864-0581		911 Dorset St., S.BurI. 05403	24	2	7/14
Schwender	Kirsie	328-009-6	05/11/63	425-3089	n/a		33		
Scolin	Lynda	072-611-7	11/13/67	985-8420	863-7370 ext.312	7 Creekside Dr., Sheib., VT 05482	29	3	6/23
Siegel	Amy	130-910-3	06/27/67	879-2937	863-7153	12 Lamoille St.,Essex Jct.,VT 04452	29	1	6/9
Smith	Christina	046-275-4	03/19/64		656-8483	Given C-258	33	3	6/16
Teague	Jennifer	338-158-9	03/04/72	862-8751	656-3533	88 Maple St. App.D, B., VT	25	2	3/29
Watson	Rebecca	155-643-0	09/04/64	655-0589		100 W.Canal St.,Winooski,VT 05404	32	2	2/17
Wyss	Vanessa	321-881-5	06/30/73	849-2132	656-4094	2187 Main St.,Fairfax,VT 05454	23	3	6/30
Yezerski	Ann	155-147-2	06/22/70	660-9951	656-4366	397 St.Paul St., B., VT	26	3	2/21

control	466	11	m. 9/8	174.5	63.6	20.9				1.257	
control				174.4	73.8	24.3				1.219	
	168.0		59.8		21.2					1.319	
done				157.0	51.7	21.0	157.2	54.2	21.9	1.116	1.119
done	454	11		163.8	66.3	24.7				1.156	
control	468	11		162.8	58.6	22.1				1.135	
				161.6	59.6	22.8					
	273	11		167.2	56.1	20.1				1.174	
control	294	11		175.0	78.0	25.5				1.207	
	473	11		159.4	57.2	22.5				1.168	
	437	11		155.6	60.8	25.1				1.151	
dropout	313	11		164.8	57.9	21.3				1.105	
control			8/1	172.4	70.1	23.6				1.179	
control	308	12	8/20	172.6	69.4	23.3				1.260	
done	295	12		172.2	66.4	22.4	172.8	64.3	21.5	1.217	
				168.4	57.4	20.2				0.995	
	441	11		161.5	51.8	19.9					
control	476	11		159.4	61.5	24.2				1.052	
	457	11		155.0	53.2	22.1				1.133	
control			8/14	166.8	62.2	22.4				1.283	
				163.0	53.2	20.0				1.121	
dropout	298	11		164.6	54.7	20.2				1.167	
	461	11	8/18	154.4	56.0	23.5				1.172	
done			8/12	167.6	62.1	22.1	167.6	66.3	23.6	1.276	1.286

3066		1047		384		1052		1436	0	1.407		1.297
3161		1044		369		1178		1547	0	1.156		1.202
3076		1163		386		761		1147	0	1.522		1.310
									0			
2289	2337	781	790	334	331	761	736	1095	1067	1.189	1.156	1.090
2638		911		324		841		1165	0	1.304		1.118
2424		749		310		853		1163	0	1.151		1.079
									0			
2593		877		324		761		1085	0	1.262		1.122
2861		985		351		761		1112	0	1.117		1.171
2343		774		272		802		1074	0	1.192		1.083
2428		790		779		314		1093	0	1.196		1.066
2601		820		351		761		1112	0	1.227		0.999
2914		1035		364		1021		1385	0	1.235		1.267
3033		1093		350		761		1111	0	1.381		1.251
3019		1098		354		761		1115	0	1.299		1.215
2106		681		280		718		998	0	0.933		0.983
								0	0			
2027		719		250		645		895	0	1.082		1.050
2214		752		273		698		971	0	1.139		1.062
2954		1030		367		1045		1412	0	1.227		1.266
2269		785		265		761		1026	0	1.213		1.117
2646		860		334		761		1095	0	1.192		1.208
2368		817		320		728		1048	0	1.233		1.177
2912	2989	1053	1097	406	417	761	978	1167	1395	1.321	1.528	1.340

	1165		26.9		25.6		16.15		43.88		46.95	0.00
	1201		31.4		30.1		21.91		47.78		50.94	0.00
	1169		23.6		22.4		13.45		43.47		46.55	0.00
										0.00	0.00	
1.122	870	888	24.5	24.7	23.5	23.6	12.34	12.74	37.99	38.88	40.28	41.21
	1002		37.8		36.3		24.03		39.51		42.15	0.00
	921		34.7		33.3		19.41		36.53		38.96	0.00
										0.00	0.00	
	985		25.6		24.5		13.85		40.15		42.74	0.00
	1087		44.3		42.7		33.49		42.10		44.96	0.00
	890		27.6		26.4		14.77		38.75		41.10	0.00
	922		37.0		35.6		21.69		36.86		39.29	0.00
	988		29.9		28.6		16.99		39.83		42.43	0.00
	1107		32.8		31.4		21.40		43.86		46.77	0.00
	1153		33.8		32.4		23.97		46.88		49.91	0.00
	1147		24.0		22.9		15.05		47.77		50.79	0.00
	800		33.6		32.3		18.41		36.43		38.54	0.00
										0.00	0.00	
	770		38.8		37.5		22.77		35.93		37.96	0.00
	841		27.8		26.7		13.94		36.11		38.33	0.00
	1123		17.8		16.9		10.41		48.11		51.07	0.00
	862		21.4		20.4		10.56		38.80		41.07	0.00
	1006		23.6		22.5		12.41		40.17		42.81	0.00
	900		29.6		28.4		15.83		37.60		39.97	0.00
1.381	1106	1136	30.6	35.0	29.2	33.4	18.78	21.84	42.65	40.58	45.56	43.57

20.44		5.02		15.65		20.66	0.00	27.55	0.00	6.43	
22.74		5.08		17.09		22.17	0.00	29.56	0.00	9.42	
22.41		4.38		13.26		17.64	0.00	23.52	0.00	6.71	
						0.00	0.00	0.00	0.00		
18.30	19.12	4.33	4.27	12.72	12.84	17.05	17.10	22.74	22.80	5.75	5.46
19.10		4.98		13.00		17.98	0.00	23.97	0.00	10.03	
17.79		4.05		12.18		16.23	0.00	21.64	0.00	9.48	
						0.00	0.00	0.00	0.00		
18.88		4.56		14.01		18.57	0.00	24.76	0.00	5.06	
19.44		5.27		15.45		20.72	0.00	27.62	0.00	13.73	
18.93		4.23		12.81		17.04	0.00	22.72	0.00	6.30	
17.93		4.22		12.34		16.56	0.00	22.08	0.00	9.38	
18.65		4.24		14.30		18.54	0.00	24.72	0.00	6.36	
21.10		5.08		15.24		20.31	0.00	27.09	0.00	6.76	
21.72		5.69		16.62		22.31	0.00	29.75	0.00	10.45	
22.96		4.90		16.97		21.87	0.00	29.16	0.00	5.94	
18.05		4.01		12.15		16.16	0.00	21.54	0.00	8.14	
						0.00	0.00	0.00	0.00		
17.39		3.99		12.72		16.72	0.00	22.29	0.00	9.43	
17.52		3.94		12.22		16.16	0.00	21.55	0.00	6.16	
13.22		5.56		16.35		21.92	0.00	29.22	0.00	4.26	
18.86		3.83		13.49		17.32	0.00	23.09	0.00	3.95	
19.19		4.33		13.87		18.20	0.00	24.27	0.00	5.10	
17.26		4.74		13.21		17.95	0.00	23.93	0.00	6.73	
20.28	20.17	5.49	4.94	14.28	12.99	19.76	17.94	26.35	23.92	8.66	10.68

1.49		6.92		8.41	0.00	2870		45.10		170		1.15
1.81		9.18		10.99	0.00	2413		32.70		201		1.16
0.96		4.71		5.67	0.00	3047		50.20		190		1.13
				0.00								
1.07	1.31	4.55	4.94	5.62	6.25	2265	2417	43.80	43.70	200	200	1.12
3.36		8.97		12.33	0.00	2330		35.14		186		1.15
1.73		6.86		8.59	0.00	1980		33.79		190		1.12
				0.00								
1.35		6.12		7.48	0.00	2017		35.95		182		1.19
4.04		13.80		17.83	0.00	2870		36.70		188		1.19
2.02		5.36		7.38	0.00	2180		38.11		190		1.10
2.52		8.22		10.74	0.00	2500		41.12		191		1.07
2.37		6.96		9.33	0.00	2577		44.51		190		1.16
2.29		8.87		11.15	0.00	2940		41.94		181		1.08
2.76		9.12		11.88	0.00	2138		30.80		200		1.19
1.10		6.59		7.69	0.00	3466	3787	52.20	58.90	188	179	1.16
1.63		7.31		8.94	0.00	1930		33.62		222		1.18
				0.00	0.00	2040		39.38		188		1.09
2.77		9.26		12.04	0.00	1710		27.80		187		1.12
1.28		5.42		6.70	0.00	2290		43.05		183		1.10
0.89		4.32		5.20	0.00	2494		40.10		189		1.25
0.85		4.72		5.57	0.00	2389		44.90		199		1.12
1.12		5.13		6.25	0.00	2210		40.40		205		1.22
1.51		6.43		7.94	0.00	2020		36.90		190		1.07
1.91	2.33	7.05	7.55	8.96	9.87	2186	2025	35.20	30.50	191	188	1.12

-10.15				167	61	66	89	2.53	< 5	13	82	64
16.85				128	30	60	62	2.13		6	14	79
11.95				184	108						79	66
				167	165	37	97	4.51				
16.21	16.98			209	97				5	18	77	74
11.25	#DIV/0!			222	132	74	122	3.00		85	75	
8.94	#DIV/0!			232	70	52	166	4.46		87	125	
	#DIV/0!			162	158	56	74	2.89		80	78	
12.32	#DIV/0!			183	81				6	51	81	96
13.61				174	111				12	45	82	76
9.62				191	65	45	133	4.24		83	58	
-12.57				157	123					80	86	
-13.50				158	64				< 5	18	68	74
8.38				156	113	48	85	3.25		82	103	
-15.51				180	83				12	22	87	75
9.52				165	33				5	40	73	78
8.95				188	101	57		3.30		90	98	
										87	89	
7.13				292	75	77	200	3.79		92	111	
9.11				206	173	58	113	3.55		84	102	
-15.11				194	121				< 5	17	86	69
9.70				179	73					90	51	
-11.70				151	59				5	33	81	72
9.65				184	81	39	129	4.72	6	37		
9.28				188	98				9	71	79	76